made at Mount Hamilton during 1898 and 1899. The elements he gives are the following :—

System II.

T = 1894·0900	$i = 46° 1'·9$
$\mu = -7°·37069$	$\Omega = 44° 30'·2$ (1900)
P = 48·8421 years	$\pi - \Omega = 212° 6'·4$
$e = 0·5875$	

The mean value of the distance of the companion is given as

$$a = 7''·594.$$

CATALOGUE OF ASTRONOMICAL INSTRUMENTS.—Sir Howard Grubb has sent us a revised edition of his catalogue of astronomical instruments, observatories, &c., showing the nature of the work turned out from his workshops at Rathmines, Dublin. The quality and performance of these are well known to practical astronomers. The catalogue in its new form will be interesting to all from the beautiful illustrations with which it is furnished, showing in a most convincing manner the capabilities of various optical and mechanical contrivances. The frontispiece is a reproduction of a photograph of η Argus taken with the astrographic telescope at the Cape Observatory. At the end of the volume there are four plates showing "The solar eclipse of 1898," "A specimen of work done by a photographic doublet of 15 inches aperture," "The great nebula in Orion," and "The Dumb-bell nebula in Vulpecula"; the two latter being from negatives taken by Mr. W. E. Wilson with a reflector of 24 inches aperture.

THE CAPE OBSERVATORY.

THE annual report of Her Majesty's Astronomer at the Royal Observatory, Cape of Good Hope, for the year 1898, has recently been published. The following is a short *résumé* of the chief details :—

The McClean Telescope.—The equatorial mounting of this instrument, the generous gift of Mr. F. McClean, F.R.S., reached Table Bay in good order on April 11, 1898. In six weeks all the parts had been mounted and adjusted, the stand, however, requiring considerable modification. The fittings for electrical illumination of the circles, scales, and micrometers had to be made or remodelled at the Cape.

The hydraulic motor for rotating the dome arrived on July 4, the hydraulic ram and valves for automatic clock-winding on October 11, and by November 1 all the essentials of the observatory and stand were fitted and in good working order. The raising and lowering of the floor and rotation of the dome are commanded by cords which may be actuated by the observer at the eye-end of the telescope with the utmost ease and delicacy, while the hydraulic clock-winding gear, contrived by Mr. McClean, automatically winds up the clock-weight at short intervals without communicating the slightest vibration to the telescope.

The 18-inch visual object-glass has proved to be a very fine one, both its spherical and chromatic corrections being practically perfect, as far as the kinds of flint and crown glass at present procurable in discs of that size will allow.

The 24-inch glass has two faults : the marginal images show well-marked *coma*, and the minimum focus, instead of being near to or more refrangible than $H\gamma$, is for rays of refrangibility between $H\beta$ and $H\gamma$. It is understood that Sir Howard Grubb will remedy these defects. The slit spectroscope for line of sight work, made by the Cambridge Scientific Instrument Company, was shipped from London on December 21, and the 24-inch glass cannot be returned for alteration until tests have been made with this spectroscope in conjunction with it.

The New Transit Circle.—The foundations for the new transit circle have been built, and the observatory, of sheet steel, is constantly expected from Messrs. T. Cooke and Sons, of York. Messrs. Troughton and Simms reported that the transit circle itself would probably be ready in March 1899.

Astronomical Observations.—The work of the *transit circle* has been chiefly devoted to observations of standard stars for reduction of the measures of the "Catalogue Photographic Plates." During the year 10,355 meridian transits and 9863 determinations of zenith distance have been recorded.

With the *Heliometer* systematic observations of the major exterior planets have been made, the year's work including fifty-three measures of Jupiter, forty-four of Saturn, forty-five of Uranus, and seventy-two of Neptune, all during opposition. This instrument has also been employed in the triangulation of twenty-one stars surrounding the South Pole, and for investigation the possibility, first suggested by Dr. Rambaut, of atmospheric chromatic dispersion affecting the accuracy of heliometer observations. The *seven-inch equatorial* has been employed for observations of occultations, revision of star-lists, and Coddington's comet; and the *six-inch telescope*, in conjunction with a Zöllner photometer, for the comparison of photographic and visual magnitudes in areas near the pole and equator of the Milky Way.

With the astrographic telescope, 469 plates have been obtained, 200 of these being "revision plates," as it is proposed to repeat the whole series of catalogue plates, in order to bring the epoch at which the plates were taken nearer to that at which the comparison stars were observed on the meridian.

Geodetic Survey of South Africa.—The field operations in connection with the geodetic survey of Rhodesia were resumed in May at the close of the rainy season, the early part of the year having been spent in training the observers in the use of the Jäderin base-measuring apparatus, the constants of which were accurately compared with the Cape measuring bars. The difference of longitude between Buluwayo and the Cape Observatory was determined by exchange of telegraphic signals on four nights, the astronomical latitude and azimuth being also observed. After the selection of a site, a base line of $11\frac{3}{4}$ miles in length was measured, and during the year seventeen stations were occupied and measurements taken therefrom.

An arrangement for the delimitation of the Anglo-German boundary between British Bechuanaland and German South-west Africa having been approved by both Governments on January 1, Lieutenant Wettstein and Major Laffan, R.E., after some months' sojourn at the observatory for practice in astronomical observations, commenced operations at Reitfontein (long. 20° E., lat. 26° 47′ S.) on November 19, by determinations of astronomical latitude and azimuth and the selection of stations.

The existing triangulation in the Cape Colony on the meridian of 20° E. long. is at present limited to the northern triangles of Sir Thomas Maclear's arc and to Bosman's accurate triangulation of Bechuanaland from Vryburg to the 20th meridian, and along that meridian from the Orange River to Reitfontein. There thus remains to complete the chain from Cape Agulhas (the southern point of Africa) to Reitfontein, a distance of only 140 miles to be filled in. The triangles for this work have been selected, and are about to be measured with the Repsold theodolite by Mr. Alston.

In connection with the survey of Rhodesia, Mr. Rhodes has promised that when he is in a position to commence the extension of the railway from Buluwayo to the Zambesi, he will place at the disposal of Her Majesty's Astronomer the funds necessary to carry on the arc of meridian from Southern Rhodesia to Lake Tanganyika. Thus there is in prospect the completion of the following valuable geodetic data :—

(1) A geodetic arc along the meridian of 20° E. long. from Cape Agulhas (lat. 34° 49′ S.) to the parallel of 22° S. lat., perhaps to 18° S. lat., *i.e.* an arc of 12° 49′, or possibly of 16° 49′ in length.

(2) An arc along the meridian of 30° E. long. from the south of Rhodesia (lat. 22° S.) to the southern extremity of Lake Tanganyika (lat. 8° 40′ S.), an arc of 13° 33′ in length. Both of these important operations will be under the direction of Her Majesty's Astronomer.

It is also hoped that the German Government will carry the latter work along the eastern border of Lake Tanganyika to Uganda, whence the way is now clear for a triangulation along the Nile to Alexandria, *i.e.* practically along the same meridian as above, 30° E. long. This latter work should for various reasons be commenced at its northern extremity.

Longitude of Lake Nyassa.—The longitude of Nkata Bay

on Lake Nyassa was determined by exchanges of signals between this station and the Observatory, made by Captain Close, R.E., and Dr. E. Kohlschutter. The adopted value for the longitude of the station occupied (which was 5·2s. west of the Bay) was

2h. 17m. 7·6s. E.,

and thus the previously accepted longitude was about six miles in error. This work was undertaken in connection with the delimitation of the Anglo-German boundary between Lakes Nyassa and Tanganyika.

Longitude of Umtali.—Similar operations undertaken by Captain Watherstone, R.E., in connection with the Anglo-Portuguese Barué Delimitation Commission, gave the longitude of Umtali as 2h. 10m. 41·2s. E.

Time Service.—The usual distribution of time signals for commercial and navigation purposes has been carried out.

PROF. F. OMORI ON EARTHQUAKE-MOTION.

THREE important memoirs have recently been published by Dr. F. Omori, Professor of Seismology at the Imperial University of Tokio.[1] In the first he describes a form of horizontal pendulum adapted for mechanical registration, a method which, like the Italian seismologists, he prefers on account of its cheapness and the more open diagrams which it provides. The pendulum consists of a thin brass cylinder, filled with lead, and weighing about 14 kg. This is attached to a horizontal tubular strut of iron, which ends in a sharp conical steel point, working in a conical steel socket fixed to the wall of an earthquake-proof house. A fine steel wire connects the heavy-bob with a triangular steel prism, whose knife-edge works in a steel V-groove mounted on a projection from the upper part of the wall. The vertical distance between the points of suspension and support is 2½ metres, the horizontal distance being, as usual, very small. The length of the strut from its pivot to the axis of the cylinder is one metre. The complete period of vibration is at present 28 seconds in one pendulum, and 17 seconds in the other. The record is made by a light pointer, connected at one end with the cylinder and turning about a vertical axis working in a stirrup rigidly connected with the ground. At the end of the long arm is hinged a light triangular writing index, the point of which rests on smoked smooth paper, which is wrapped round a light wooden drum, 942 mm. in circumference, and revolving once an hour. While the Italian seismologists endeavour, as a rule, to render their instruments sensitive by using a heavy steady mass, Prof. Omori attains the same end by reducing the friction between the parts of the machine; for instance, the pressure of the writing index on the smoked paper is only ⅕ mgm. Prof. Omori also describes a portable form of the pendulum, in which the dimensions and heavy mass are smaller, and the points of suspension and support are connected with a cast-iron stand. The paper is illustrated by some interesting typical diagrams given by the pendulums of pulsatory oscillations and earthquake disturbances of neighbouring and distant origin.

It is well known that most earthquakes begin with a preliminary tremor, consisting of vibrations whose amplitude is very small and whose period is generally very short. When the origin of the earthquake is distant, the duration of the tremors, as noticed by Prof. Milne and others, increases with the distance of the observing station; and a similar relation, as Prof Omori points out in his second paper, is evident from an examination of different seismograms obtained in Japan. He shows that the duration of the preliminary tremor does not depend on the magnitude of the disturbed area of the earthquake, for no difference of this kind is to be seen between the disastrous Mino-Owari earthquake of 1891 and its five strongest after-shocks. He finds, moreover, that, for great earthquakes originating at distances between 100 and 1000 km., the duration increases by 15 seconds for every increase of 100 km. in the distance from the origin. The duration of the tremor being ascertained at two or more stations, it is thus possible to determine the position of the epicentre; and, in two cases which are given the results agree closely with those obtained from isoseismal lines. Prof. Omori remarks that the approximate variation of the duration of the early tremors with the distance from the origin can be explained by assuming the existence of two sets of waves, which, starting simultaneously, are propagated with different velocities. The mean velocities for the Mino-Owari earthquake of 1891 and the Hokkaido earthquake of 1894 are 2·2 km. per sec. for the preliminary tremors and 1·7 km. per sec. for the principal waves.

The third paper, written in conjunction with Mr. K. Hirata, is a valuable discussion of the earthquake measurements made at Miyako from June 1896 to June 1898. The observatory, which contains a Gray-Milne seismograph, is situated on a small promontory of palæozoic rocks (in lat. 39° 38′ N. and long. 141° 59′ E.), and the records may therefore be regarded as good illustrations of earthquake measurements in a rocky district. Of the twenty-five earthquakes which form the principal subjects of the discussion, six originated in the mountainous regions to the west, and the remaining nineteen under the Pacific Ocean, the point one degree east of Miyako being the most active centre of the earthquakes which disturb the eastern part of Northern Japan. The authors arrive at the following important conclusions. As a general rule, the duration of an earthquake seems to vary directly as the magnitude of the disturbed area and inversely as the distance of the observing station from the origin. The average duration of the vertical component is about four-fifths that of the horizontal component. The period of the maximum movement, both horizontal and vertical, ranges between 0·53 and 1·7 seconds for slow undulations, and between 0·12 and 0·15 second for ripples. The average period of the horizontal slow undulations is approximately constant in the principal and end portions of an earthquake, while that of the ripples is slightly greater during the principal portion than during the preliminary tremors and end portion. It is remarkable that the average period of ripples is roughly constant in all the earthquakes here considered, never varying much from one-tenth of a second. The range of the vertical motion was invariably less than that of the corresponding horizontal motion, the maximum vertical motion being on an average one-fifth of the maximum horizontal motion; and this is true both for ripples and slow undulations. The direction of the maximum earthquake movement, as a rule, is coincident with the direction of the line joining the observing station to the centre. In two earthquakes (those of February 7 and April 30, 1897), the angle of emergence can be ascertained as well as the position of the epicentre, and from these data the focal depths are found to be 15 and 9 km. respectively.

[1] (1) "Horizontal pendulums for registering mechanically earthquakes and other earth movements": *Journ. Coll. Sci., Imp. Univ., Tokio*, vol. xi. 1899, pp. 121–145; (2) "Note on the preliminary tremor of earthquake-motion": *ibid.*, pp. 147–159; (3) "Earthquake measurement at Miyako": *ib id.*, pp. 161–195.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. A. W. BRIGHTMORE has been appointed professor of engineering construction and surveying at the Royal Indian Engineering College, Cooper's Hill.

ALL particulars referring to the technological examinations conducted by the City and Guilds of London Institute, and the regulations for the registration and inspection of classes in technology and manual training, will be found in the official "Programme" just published by Messrs. Whittaker and Co. The syllabuses of the seventy different subjects, with the list of works of reference in each, and the examination papers set this year, should prove of service both to teachers and students of technology.

THE ninth summer meeting of University Extension Students in Oxford terminated on Wednesday, August 24. The meeting was throughout uniformly successful. It was divided, as usual, into two parts, the first part terminating on August 9. The number of visitors to the meeting amounted to about 1000. Of these considerably over 100 came from Germany and the United States, other nationalities being fairly well represented. The historical period selected for study was the nineteenth century from 1837, and the scientific section of the meeting was therefore necessarily occupied with the more important results obtained during that period. The lectures were well attended and excited considerable interest. In Part I., Prof. Gotch gave two lectures on "The physiology of sensation," Mr. G. C. Bourne two on "The growth of the living organism," and Prof. H. A.